

# INDEX: SEVERE SERVICE SOLUTIONS

Section	Product	Liquid	Gas	Dirty Service	$\sigma$	Attenuation	Notes
14-01	LOW COST OPTIONS	x	x	Lowest Clogging Potential	$1.5 \leq \sigma \leq 2.0$	$\leq 15$ dBA	These options should be considered prior to implementing severe service trim.
14-02	CAVCONTROL	x		Low Clogging Potential	$1.2 \leq \sigma \leq 1.5$		Minimizes damage in moderate cavitation, but does not prevent cavitation. Hardened retainer and angle body can extend $\sigma$ down to 1.10
14-03	MICROCAV	x		Low Clogging Potential	$\sigma \geq 1.004$		Manages cavitation in low flow conditions ( $0.007 \leq C_V \leq 1.25$ ). Flow limitations cannot be exceeded.
14-04	CAVSTREAM	x		High Clogging Potential	$1.002 \leq \sigma \leq 1.5$		Controls cavitation in low flow conditions ( $0.5 \leq C_V \leq 2.5$ ). Easy to retrofit into Mark One or Mark Two valves.
14-05	CHANNELSTREAM	x		High Clogging Potential	$\sigma \geq 1.002$		Liquid services with high flow, moderate to severe cavitation, temperatures up to 1200° F (650° C), and 15,000 psi (1034 bar).
14-06	MEGASTREAM		x	Moderate-High Clogging Potential		$\leq 30$ dBA	The new small-hole design reduces the number of stages required, resulting in substantial savings. Try sizing a one or two stage trim with a plate instead of a three to six stage trim.
14-07	STEALTH		x	Moderate Clogging Potential		$\leq 30$ dBA	TOP SECRET
14-08	TIGER-TOOTH		x	Moderate Clogging Potential	$\sigma \geq 1.002$	$\leq 30$ dBA	Design allows the trim to control flow pressure and velocity, dramatically reducing noise level. Expensive, use MegaStream as a low-cost alternative.
14-09	MEGASTREAM PLATE		x	Moderate Clogging Potential		$\leq 30$ dBA	Try sizing a one or two stage trim with a plate instead of a three to six stage trim.
14-10	MEGASTREAM DIFFUSERS		x	Moderate Clogging Potential		$\leq 15$ dBA	Handle larger flow rates than those of a MegaStream Plate.
14-11	MEGASTREAM VENT ELEMENTS		x	Moderate Clogging Potential		$\leq 25$ dBA	A cost effective solution for systems requiring moderate to high noise attenuation
14-12	MEGASTREAM IN-LINE SILENCERS		x	Moderate Clogging Potential		$\leq 15$ dBA	Silencers are designed to handle very high-pressure drops and noise. Using a silencer instead of specialized trim is much more cost efficient.
14-13	TIGER-TOOTH VENT ELEMENTS		x	Moderate Clogging Potential		$\leq 30$ dBA	A very effective solution for systems requiring high noise attenuation. Tiger-tooth vent elements are generally more expensive than other options.

# SEVERE SERVICE EQUIPMENT SELECTION

## 14.1 OTHER OPTIONS TO SEVERE SERVICE TRIMS

The following solutions should be considered prior to implementing severe service trim:

**HARDENED TRIM** – For globe valves experiencing cavitation, the base trim material can be reinforced by hardening the seat, bore and plug contour. Hardening may be done by weld-applied hard facing, heat treatment, or by casting hard alloys, such as Alloy 6. Hardened trim materials reduce the incipient damage coefficient ( $\sigma_{id}$ ) slightly. In addition, the rate of metal erosion is greatly reduced in some low-pressure applications.

Experience suggests that very small flow rates or very low pressures do not produce significant damage on hardened surfaces, even though the service Sigma ( $\sigma$ ) is less than  $\sigma_{id}$  of the valve at operating conditions. If hardened trim does not provide enough damage protection, then CavControl trim or a multi-stage trim may be required.

Body material can be eroded when operating at  $\sigma < \sigma_v$  or  $\sigma_p$ . Globe bodies smaller than 2-inch (DN 50) seem to be at greatest risk due to the short distances available for dissipation of the cavitating stream. Angle bodies or special body materials (such as Chrome-Moly or stainless steel) should be considered for small bodies where  $\sigma < 1.20$ .

**CHANGING THE PROCESS FLOW CONDITIONS** – If possible, the velocity or pressure drop may be varied by slightly changing the upstream or downstream pressures, which may lessen the cavitation damage or noise generation.

**LOCATION OF THE VALVE** – When the valve is generating unsafe noise levels; the valve may be relocated to an area away from reflective surfaces or from workers.

**USE OF EAR PROTECTION OR INSULATION** – To mitigate unsafe noise levels, workers may be required to wear ear protection or to limit time spent near the source of the noise. Sound insulation may be used around the valve or downstream piping to lower the sound pressure level.

**STYLE OF THE VALVE BODY** – Changing a particular valve body style may decrease effects of a severe service condition.

**INSTALLED FLOW DIRECTION OF THE VALVE BODY** – If flow direction is not critical to the application, a valve can be reversed in the line. This change in the flow path may lessen the effects of the severe service condition.

**INCREASE FRICTIONAL LOSSES** – Increasing the frictional losses with several piping right-angle piping turns may control downstream turbulence and noise. The frictional loss associated with a right-angle turn is equal to that associated with a 60-foot (18.288 m) length of straight pipe.

**THICKER PIPING WALL SCHEDULE** – A heavier schedule of pipe can be used to minimize vibration in downstream piping.

**USE OF MULTIPLE VALVES OR DOWNSTREAM RESTRICTION DEVICES** – Installing two or more valves close together or a down-stream restriction device downstream from a valve may create a staged pressure reduction.

**USE OF DOWNSTREAM NOISE SUPPRESSION EQUIPMENT** – Installing downstream plates, diffusers and vents from a control valve will lower sound pressure levels and vibration.

# SEVERE SERVICE EQUIPMENT SELECTION

## 14.02 CAVCONTROL TRIM

### Introduction

CavControl trim is a cost-effective trim that effectively minimizes cavitation damage to valve components by controlling the location of vapor bubble implosion in an area away from metal parts.

### Design

CavControl trim utilizes a number of small diametrically opposed flow holes through the walls of a special seat retainer (Figure 14.2.1). Flow direction for valves with CavControl trim is always over the plug. As the valve plug lifts off the seat, increasing pairs of holes are opened. Each hole admits a jet of cavitating liquid, which impinges in the center of the retainer upon the jet of liquid admitted through the opposing hole (Figure 14.2.2). The impinging fluid jets form a fluid cushion and an area of pressure recovery that causes the collapse of the vapor bubbles in the fluid stream away from metal parts. Stepped holes are used to ensure orifice type flow rather than tube type flow through the retainer; thus, the vena contracta is established externally rather than inside the retainer itself. The turbulence of the impinging flow promotes the collapse of vapor bubbles at the center of the seat retainer, minimizing damage to valve trim. CavControl trim fits standard Valtek bodies, with both pressure-balanced and unbalanced trims available.

### Maintenance

CavControl is designed to allow for easy maintenance, reliability, performance and high interchangeability of parts with other valve models. Designs are simple, straightforward and require no special tools.

### Flow Capacity and Trim Characteristics

Flow Capacity and characteristics are determined by the size and spacing of the holes in the seat retainer. Different sized holes and variable spacing can be used on the same retainer to achieve a desired flow characteristic. The required flow capacity of an application can be determined through the standard ISA sizing equations. The main difference in sizing a standard globe valve and a CavControl valve is that the CavControl valve generally has lower pressure recovery and is less likely to choke thus providing more flow for a given flow capacity and pressure drop.

### SIZING TIPS:

- **SIZING HIGH PRESSURE DROPS FOR FLASHING:** These problems contain aspects of both flashing and cavitation. The procedure to solve these problems is to break the problem into two conditions, solving for cavitation and flashing separately. Then combine the results. Typically, the process will be dominated by either cavitation or flashing with minimal effects caused by the lesser of the two. In these cases, the valve can be sized primarily for the major flow characteristic. Below are the steps for calculating a solution:
  1. SET  $P_{2A} = P_v + 15$ . Size the valve for cavitation using  $P_1$  and substituting  $P_{2A}$  for  $P_2$ .
  2. SET  $P_{1A} = P_v + 15$ . Size the valve for flashing substituting  $P_{1A}$  as  $P_1$  and using the original value for  $P_2$ .
  3. Combine the features of step one and step two for the solution.

#### \*ADVANTAGES

- CAVITATION CONTROL
- EASY MAINTENANCE
- TIGHT SHUTOFF

#### \*APPLICATION

- LIQUID SERVICES
- TEMP  $\leq 1200^\circ\text{F}$  ( $650^\circ\text{C}$ )
- P  $\leq 15$  KPSI (1034 BAR)



Figure 14.2.1: CavControl Trim

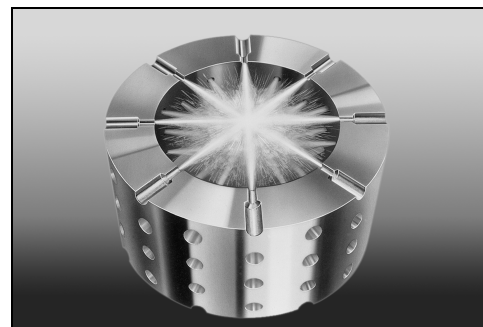


Figure 14.2.2: Impinging Flow Path of the CavControl Trim

## SEVERE SERVICE EQUIPMENT SELECTION

### 14.03 MICROCAV TRIM

#### Introduction

MicroCav trim is used to manage cavitation in Valtek control valves requiring small flow rates ( $0.007 \leq C_v \leq 1.25$ ). The  $C_v$  design limitations must not be exceeded.

#### Design

The MicroCav design utilizes a special plug that is closely guided within the seat ring. The plug head consists of a series of grooves that continually expand as they progress diagonally along the length and around the circumference of the plug head (Figure 14.3.1) – causing the grooves to continually intersect each other. As fluid passes through the grooves, it experiences multiple stages of pressure reduction mechanisms including: mixing, mutual impingement, small passages, and turns. The venturi seat ring forms one boundary of the flow path, forcing all of the flow through the multiple stages of pressure reduction. These simple mechanisms effectively control severe and moderate cavitation in low  $C_v$  applications. In addition, the MicroCav's expanding grooves are self-cleaning washing away debris without buildup. This allows MicroCav to continue working effectively in dirty services – a marked advantage over most anti-cavitation trims, which are limited to clean services.

#### Application

The MicroCav trim design is available for installation in both angle and globe style bodies. Angle bodies are strongly preferred because the bonnets and retainers used in the globe version must be custom engineered for specific applications. All globe valve applications must undergo a dimensional and process sigma review by the factory. The globe valve body material should be Chrome-Moly. Trim designs of 0.69B and larger can only be used in an angle style body. This is due to the length of the plug head and potential damage that could be caused to the body. Due to the narrow clearances, it is recommended that the plug and seat ring material have a differential hardness to reduce the potential for galling. Even though the plug head is guided, a solid lower guide is required for proper stem support. The preferred materials of construction are 400 series stainless steel plug (416 SS HT) and seat ring (420 SS HT). Alternative hardened materials are available such as 316/Alloy 6 for added corrosion resistance. Replacement trim sets must be purchased and manufactured as a matched set.

#### Flow Characteristic

MicroCav trim has a modified equal percentage characteristic which cannot be changed. The rangeability is 40:1.

### SIZING TIPS:

- **METAL EROSION RATES:** The rate of metal erosion is greatly reduced in some low-pressure applications. Very small flow rates or very low pressures do not produce significant damage on hardened surfaces, even though the service sigma ( $\sigma$ ) is less than  $\sigma_{id}$  of the valve at operating conditions.
- **FLUIDS OTHER THAN WATER:** *Performance!*<sup>®</sup> calculates sigma based on water. Different fluid properties such as viscosity can dramatically affect cavitation; therefore consult engineering for specific fluid properties.
- **CONTACT THE FACTORY** for specific sizing information.

#### \*ADVANTAGES

- SEVERE/MODERATE CAVITATION
- SELF CLEANING
- EASY MAINTENANCE
- TIGHT SHUTOFF

#### \*APPLICATION

- OVER-THE PLUG FLOW
- LIQUID SERVICES
- LOW FLOW:  $0.007 \leq C_v \leq 1.25$



Figure 14.3.1: MicroCav Plug Uses Expanding Grooves to Control Cavitation

# SEVERE SERVICE EQUIPMENT SELECTION

## 14.04 CAVSTREAM

### Introduction

The CavStream severe service trim is a close guided single- or multi-stage anti-cavitation trim used for low  $C_v$  and retrofit applications. The CavStream trim uses a combination of several existing anti-cavitation technologies and offers moderate (single-stage) and high (multi-stage) cavitation protection for low flow service ( $0.5 \leq C_v \leq 2.5$ ).

The single-stage CavStream is a CavControl (Figure 14.4.1) cylinder built into the plug head. It uses the CavControl style stepped holes that are counter-bored into the skirt. These stepped holes are diametrically opposed to allow vapor bubbles in the fluid stream to collapse away from the metal parts. Currently, engineering data tables on the CavStream trim are not available. The  $C_v$  data is determined specifically for each application. For sizing purposes, the single-stage CavStream it may be modeled in Performance as a CavControl with a custom  $C_v$  selection.

High cavitation conditions in low flow service can be controlled using a multi-stage CavStream (Figure 14.4.2). The cartridge/plug is closely guided in the seat ring. Within the plug head, the cylindrical stages of the ChannelStream are retained. Although located in the plug head and not in the seat retainer, they are identical in design and function to the standard cartridge. As the cartridge/plug strokes through the seat, the flow area increases as additional expansion holes are exposed to the flow. Some advantages of using the CavStream design is it's simplicity, it does not require the use of an angle-style body and can be easily retrofitted into standard Valtek Mark One or Mark Two valves.

### Maintenance

CavStream trim should only be applied in clean service. The small  $C_v$  requirements are obtained by making some of the flow passages as small as 0.015". These passages can be easily clogged by the particles in the process. Typical rangeability of the CavStream is approximately 30:1. The rangeability can be improved by adding optional labyrinth grooves in the seat ring as shown in the inset of Figure 14.4.2. These trims can be applied in applications with a  $C_v$  ranging from 0.5 to 2.5. Exceeding the flow limits is inadvisable.

### SIZING TIPS:

- **SINGLE-STAGE:** Single-stage CavStream can be approximated in *Performance*® as a CavControl with a custom  $C_v$ .
- **MULTI-STAGE:** Multi-stage CavStream can be approximated in *Performance*® as a normal ChannelStream valve.
- **REDUCED METAL EROSION RATES:** Experience has shown the rate of metal erosion is greatly reduced in some low-pressure applications. Very small flow rates or very low pressures do not produce significant damage on hardened surfaces, even though the service sigma ( $\sigma$ ) is less than  $\sigma_{id}$  of the valve at operating conditions.

#### \*ADVANTAGES

- Eliminates Cavitation
- Easy Maintenance
- Tight Shutoff

#### \*APPLICATION

- Flow Must Be Over-the-Plug
- Liquid Service
- Clean Service Only
- Sizes: 0.5"-2" (15-50 DN)
- Flow:  $0.5 \leq C_v \leq 2.5$

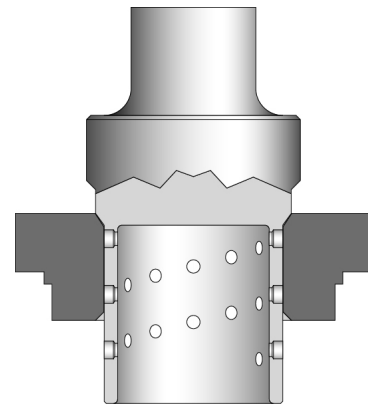


Figure 14.4.1: CavStream Single-Stage trim

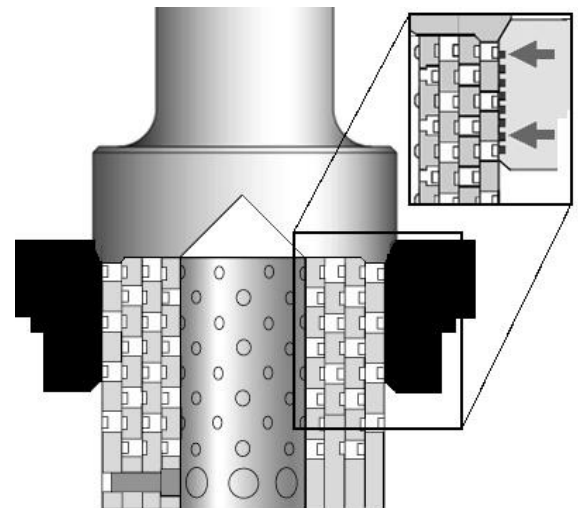


Figure 14.4.2: CavStream Multi-Stage trim (inset depicts the optional labyrinth grooves.)

# SEVERE SERVICE EQUIPMENT SELECTION

## 14.05 CHANNELSTREAM TRIM

### Introduction

ChannelStream trim prevents cavitation damage and minimizes hydrodynamic noise even under the most severe liquid applications. This unique, patented design not only eliminates cavitation damage, but also provides easy maintenance and long life even when installed in the most difficult applications. The ChannelStream cartridge may appear similar to other competitive designs because of its drilled holes and close-fitting cylinders but here the similarity ends. Rather than acting as a flow restriction, the drilled holes in the ChannelStream cartridge are used as expansion areas for the fluid as it enters from restrictive channels machined in the outside of all interior cylinders. This prevents the fluid recovery from occurring adjacent to a critical trim surface. Successive intersections of the restrictive channels result in additional pressure losses while expansion holes connected to the channels create a series of expansions and contractions that result in a series of pressure drops. This staged pressure drop eliminates cavitation in most applications and minimizes the energy of cavitation that may still occur in others.

### Standard Cartridge Design

The standard ChannelStream trim is designed for flows of 2.5  $C_v$  and higher, and utilizes a *cartridge* design in lieu of a seat retainer. With this design, flow is directed over the plug through a series of close-fitting cylindrical stages, called the *cartridge* (Figure 14.5.1). Each stage is designed with a series of expansion holes and intersecting circumferential channels that restrict the flow. As shown in Figure 14.5.2, flow travels first through the expansion holes in the outer cylinder and then enters the special-engineered channels machined into the outer surface of the second cylinder. The liquid is confined to the channel until it reaches the intersecting expansion hole in the second cylinder and passes through to the next restrictive channel, and so forth. This flow path of multiple restrictions and enlargements reduces the pressure gradually across each trim cylinder, avoiding the sharp pressure drop typical of conventional, single-throttling-point trims.

The number of stages and the flow area of the channels in each stage of the ChannelStream cartridge are designed to produce the desired overall pressure drop, while avoiding cavitation at any point. The flow area of the channel is usually greater in each successive stage in order to minimize the number of stages. This results in higher-pressure drops being taken in the outer (or initial) stages as compared with the inner (or final) stages.

A number of holes are machined near the top of the ChannelStream cartridge. Several of these holes allow fluid to vent upstream from the volume above the plug during normal operation. Other holes are for pinning the stages of

#### \*ADVANTAGES

- CONTROL CAVITATION
- EASY MAINTENANCE
- TIGHT SHUTOFF

#### \*APPLICATION

- LIQUID SERVICES
- TEMP  $\leq$  1200°F (650°C)
- P  $\leq$  15 KPSI (1034 BAR)

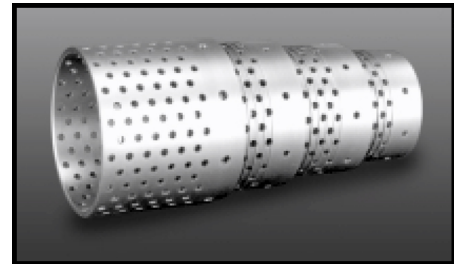


Figure 14.5.1: ChannelStream Cartridge (separated to show individual stages)

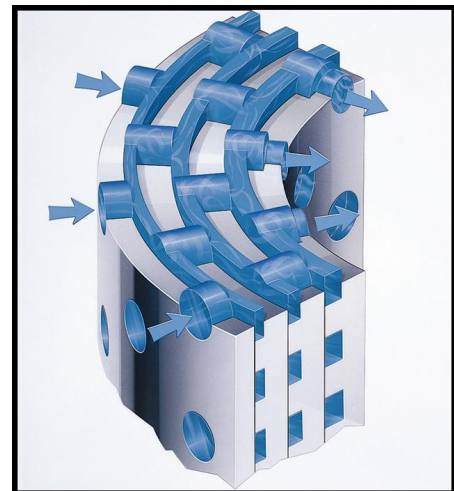


Figure 14.5.2: Flow path through ChannelStream cartridge

trim together in the correct rotational alignment. The pins and alignment holes have shoulders to index the proper position within the cartridge. A small bead weld prevents the pin from loosening. (The bead weld can be easily ground or machined out for disassembly.) The plug fits closely inside the cartridge bore and is designed to uncover or cover the inner expansion holes, controlling the flow. Both the plug and ChannelStream cartridge can be used with either metal or resilient insert seat rings. Both unbalanced and pressure-balanced designs are available (Figures 14.5.3 and 14.5.4).

Valtek control valves with ChannelStream cartridge trim are manufactured in sizes 1.5 through 14-inch, utilizing conventional Valtek globe-style bodies. All parts, except the ChannelStream cartridge, plug, bonnet, and pressure-balanced sleeve, are interchangeable with conventional Valtek Mark One globe valves, which reduces costs by creating a smaller parts inventory. Valves in sizes 16 through 36-inch may be custom-fabricated using an angle body configuration with the inlet at the side and the outlet on the bottom. To minimize the costs associated with large globe valve bodies, angle bodies in ANSI Classes 150 through 600 are generally constructed from a modified pipe 'Tee' with welded flanges. For applications requiring long strokes, long-stroking cylinder actuators are available.

### Pressure Reduction Mechanisms

The gradual reduction in pressure through ChannelStream trim results from many physical mechanisms including:

1. Sudden expansion of the flow areas as the liquid exits the restrictive channels and enters the intersecting expansion holes
2. Frictional losses due to multiple, small passageways
3. Directional changes of the process fluid
4. Turbulent mixing in the expansion holes
5. Mutual impingement of opposing streams in the expansion holes

In addition, the small channel size generates only small, rapidly dissipated vortex turbulence, reducing vortex cavitation associated with larger flow geometries. The above mechanisms (occurring in multiple stages) minimize pressure recovery.

### Velocity and Pressure

The velocities at the inlet and outlet of a Valtek control valve with ChannelStream trim are generally designed for a maximum of 30 feet per second and fluid velocities interior to the valve are closely controlled. In addition, the valve is designed to ensure that the pressure of the fluid in the valve body is always greater than the liquid vapor pressure.

### Flow Characteristics

ChannelStream trim can be designed with a linear flow characteristic, producing essentially equal changes of flow with equal changes in valve stroke. The linear flow cartridge design consists of an axially uniform hole and channel pattern. The linear flow design is commonly used for high-drop liquid applications. Equal percentage flow cartridges are also available. They are designed with a non-uniform hole pattern, along with a corresponding axial change in the area of the restrictive channels.

### Maintenance

Many comparative anti-cavitation valves utilize cage designs that can experience sticking problems between the plug-head and the cage. The standard ChannelStream cartridge avoids such problems since the cartridge's smooth, continuous inner-stage surface allows close-clearance plug motion.

Anti-cavitation valves are typically constructed with small flow passages that can become plugged by dirt or other debris in the fluid stream. Such devices usually direct the flow initially to the throttling plug before passing it through the restrictive device. This results in sticking and galling as dirt and other material become trapped between the sliding plug and the inside surface of the anti-cavitation device. To prevent this, ChannelStream is designed with two important protective features:

*First*, flow is first brought through the cartridge and contaminants too large to pass through the small outer channels is trapped at the outer-most stage of the cartridge preventing debris from traveling through the device to the throttling plug.

*Second*, because the inner channels progressively become larger, small particles (which pass through the first set of channels) are easily passed through the rest of the cartridge. The trim can be easily disassembled and cleaned in the unlikely event that the cartridge does become plugged.

### Flow Capacity

In choosing a valve for a particular application, the user should consider not only the  $C_v$ , but also the velocity and the Sigma value that must be accommodated. The required flow capacity of an application can be determined through the standard ISA sizing equations. The main difference in sizing a standard globe valve and a ChannelStream valve is that the ChannelStream valve is far less likely to choke thus providing more flow for a given flow capacity and pressure drop.

The ChannelStream trim information in the tables in section 15 are not intended to provide a complete listing of all available designs. Rather, they can be useful in estimating capabilities of a particular valve size and pressure class.

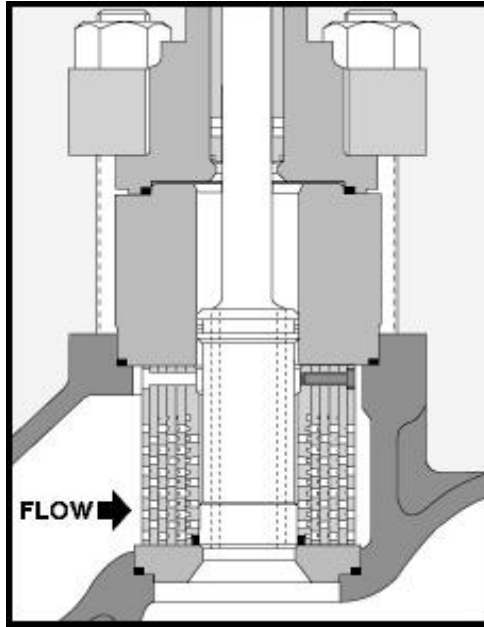


Figure 14.5.6: Pressure-Balanced ChannelStream Trim

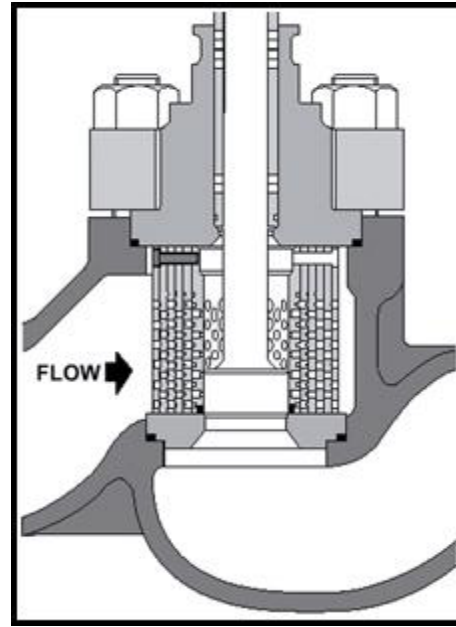


Figure 14.5.7: ChannelStream UnBalanced Design

## SIZING TIPS:

- **OIL APPLICATIONS:** In oil processes the sigma is actually higher than predicted by *Performance*<sup>®</sup>. The adjusted sigma equation is:  $\sigma_A = 1 + ((\sigma_P - 1) \times 2)$   
For example: if  $\sigma_P = 1.2$  then:  $\sigma_A = 1 + ((1.2 - 1) \times 2) = 1.4$
- **CHANNELSTREAM SIZING:** If  $P_2 \leq (P_V + 15)$ , adjust  $P_2$  by adding 15 ( $P_{2A} = P_2 + 15$ ). Resize the ChannelStream using  $P_{2A}$ .
- **SIZING HIGH PRESSURE DROPS FOR FLASHING:** These problems contain aspects of both flashing and cavitation. The procedure to solve these problems is to break the problem into two conditions, solving for cavitation and flashing separately. Then combine the results. Typically, the process will be dominated by either cavitation or flashing with minimal effects caused by the lesser of the two. In these cases, the valve can be sized primarily for the major flow characteristic. Below are the steps for calculating a solution:
  1. SET  $P_{2A} = P_V + 15$ . Size the valve for cavitation using  $P_1$  and substituting  $P_{2A}$  for  $P_2$ .
  2. SET  $P_{1A} = P_V + 15$ . Size the valve for flashing substituting  $P_{1A}$  as  $P_1$  and using the original value for  $P_2$ .
  3. Combine the features of step one and step two for the solution.
- **UNITS:** Double-check to ensure that each of your process conditions is using the correct units.
- **FLOW DIRECTION:** Changing the flow direction changes results in some scenarios.
- **FLUIDS OTHER THAN WATER:** *Performance*<sup>®</sup> calculates sigma based on water. Different fluid properties such as viscosity can dramatically affect cavitation; therefore consult engineering for specific fluid properties.
- **CRYOGENIC FLUIDS:** Cryogenic applications have much lower fluid energy levels than warmer fluids. Therefore cavitation is typically much less severe at cryogenic applications.
- **GLOBE VALVES:** experience minimal cavitation damage when operating at low pressure ( $1.7 < \sigma < 2$ ). Generally, in these cases, no cavitation control trim is necessary. However, between Sigma 1.7 and 1.2, some cavitation control is usually required. When the Sigma index for a valve is less than 1.2 the potential for severe cavitation damage exists and a staged pressure drop severe service trim must be included in the valve's sizing.



## SEVERE SERVICE EQUIPMENT SELECTION

### 14.06 KÄMMER 11000 SERIES HIGH-PRESSURE, LOW-FLOW ANGLE CONTROL VALVE

#### Introduction

The Kämmer 11000 Series control valve is used in high-pressure applications that require extremely low flows. For severe services, it utilizes a cascade-style, axial-flow trim. It features a barstock split-body design for easy maintenance and is available with a standard single-seated trim, low-noise cage trim, ceramic or tungsten carbide trim, or a soft seat. Rangeability is between 25:1 for micro-flow services and 50:1 for low-flow services.

#### Design

Single-seated multi-stage trim, barstock split-style angle body, plug-head/stem guiding, clamped-in seat ring

#### SIZING TIPS:

- **METAL EROSION RATES:** Experience has shown the rate of metal erosion is greatly reduced in some low-pressure applications. Very small flow rates or very low pressures do not produce significant damage on hardened surfaces, even though the service sigma ( $\sigma$ ) is less than  $\sigma_{id}$  of the valve at operating conditions.
- **CRYOGENIC FLUIDS:** Cryogenic applications have much lower fluid energy levels than warmer fluids. Therefore cavitation is typically much less severe at cryogenic applications.
- **FLUIDS OTHER THAN WATER:** *Performance!*<sup>®</sup> calculates sigma based on water. Different fluid properties such as viscosity can dramatically affect cavitation; therefore consult engineering for specific fluid properties.

#### \*ADVANTAGES

- ♦ Faster delivery (body manufactured from barstock eliminates casting delays)
- ♦ Easy maintenance
- ♦ Bubble-tight shutoff with soft seat
- ♦ Bellows seal and normalizing fin extension options available
- ♦ Low-noise, hardened and multi-stage high-pressure letdown trims available

#### \*APPLICATION

- ♦ High-pressure, low-flow applications
- ♦ -320° to 800° F (-196° to 427° C)
- ♦ ≤ 60,000 psig (4,140 bar)
- ♦ Clean Service Only
- ♦ Sizes: 0.125"-0.5" (4-15 DN)

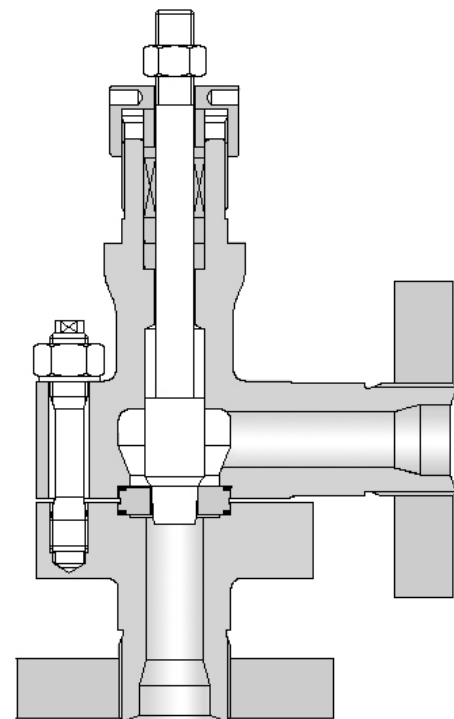


Figure 14.6.1: Kämmer 11000 Series

## SEVERE SERVICE EQUIPMENT SELECTION

### 14.07 KÄMMER 15000 SERIES HIGH-PRESSURE, LOW-FLOW ANGLE CONTROL VALVE

#### Introduction

The Kämmer 15000 Series control valve is used in high-pressure applications. For severe services, it utilizes a cascade-style, axial-flow trim. It features a barstock split-body design for easy maintenance and is available with a standard single-seated trim, low-noise cage trim, ceramic or tungsten carbide trim, or a soft seat. Rangeability is 50:1.

#### Design

Single-seated multi-stage trim, barstock split-style angle body, plug-head/stem guiding, clamped-in seat ring

#### SIZING TIPS:

- **METAL EROSION RATES:** Experience has shown the rate of metal erosion is greatly reduced in some low-pressure applications. Very small flow rates or very low pressures do not produce significant damage on hardened surfaces, even though the service sigma ( $\sigma$ ) is less than  $\sigma_{id}$  of the valve at operating conditions.
- **CRYOGENIC FLUIDS:** Cryogenic applications have much lower fluid energy levels than warmer fluids. Therefore cavitation is typically much less severe at cryogenic applications.
- **FLUIDS OTHER THAN WATER:** *Performance!*<sup>®</sup> calculates sigma based on water. Different fluid properties such as viscosity can dramatically affect cavitation; therefore consult engineering for specific fluid properties.

#### \*ADVANTAGES

- ♦ Faster delivery (body manufactured from barstock eliminates casting delays)
- ♦ Split-body and clamped-in seat for easy maintenance
- ♦ Bubble-tight shutoff with soft seat
- ♦ Bellows seal and normalizing fin extension options available
- ♦ Low-noise, hardened and multi-stage high-pressure letdown trims available

#### \*APPLICATION

- ♦ High-pressure, low-flow applications
- ♦ -320° to 800° F (-196° to 427° C)
- ♦ ANSI Class 1500-2500 (PN 250-400) ≤ 10,000 psig (690 bar)
- ♦ Clean Service Only
- ♦ Sizes: 0.5"-2.0" (15-50 DN)
- ♦ Flow:  $0.5 \leq C_v \leq 2.5$

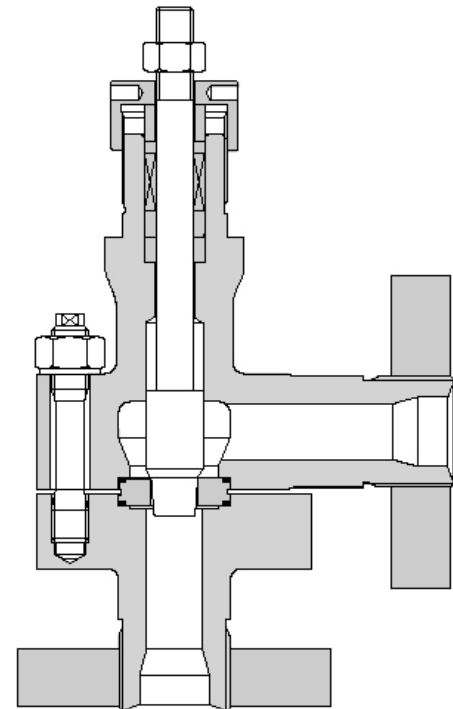


Figure 14.7.1: Kämmer 15000 Series

# SEVERE SERVICE EQUIPMENT SELECTION

## 14.08 MEGASTREAM TRIM

### Introduction

MegaStream valve trim effectively reduces control valve noise in gas applications. MegaStream trim is available in two styles: a very economical, interchangeable one or two-stage design for noise reduction up to 15 dBA, and a highly effective multi-stage design for noise reduction approaching 30 dBA.

MegaStream trim eliminates the problem of control valve noise by dealing effectively with gaseous pressure reduction, and by controlling turbulence carried into the downstream piping. The pressure drop in MegaStream trim is distributed so that it occurs at each stage, from the inside of the attenuator to the outside. This pressure drop occurs largely as a result of the sudden expansions and contractions that take place as the flow passes through the MegaStream trim. Each stage is designed to take a small pressure drop, avoiding the high velocities present in single-throttling-point trims.

### One and Two-stage Attenuator Design

MegaStream valves equipped with a one or two-stage seat retainer (called an *attenuator*) represent an extremely economical and innovative approach to low noise applications by permitting up to 15 dBA noise reduction. Standard attenuators (Figure 14.8.1) are constructed from heavy-duty drilled-hole cylinders.

A standard design exists for each valve size; so special engineering is not required. This results in lower prices and quicker deliveries. Because of parts interchangeability with standard seat retainers, one and two-stage attenuators can be fitted into conventional Valtek Mark One valves without special or additional parts. The simplicity of design also permits easy removal and maintenance. Both one and two-stage MegaStream trims are available in either unbalanced or pressure-balanced.

### Multi-Stage Attenuator Design

For larger noise reduction levels (up to 30 dBA), multi-stage attenuators incorporate from three to seven drilled-hole stages, which are welded in place. The outer stage is manufactured to an exact height to allow the proper gasket compression to be applied to both the bonnet and seat gasket.

Multi-stage MegaStream trim (three stages and above), through 14-inch, are usually installed in standard Mark One globe-style valves. (Except for the multi-stage MegaStream attenuator, all other parts of these valves are interchangeable with the Mark One control valve).

MegaStream trim for valve sizes 16 through 36-inch can be supplied in a globe valve but are commonly installed in an angle body configuration with the inlet on the bottom and the outlet on the side. Because these bodies are fabricated, the construction usually includes a small inlet with a large outlet – an arrangement ideal for velocity control.

As a cost-saving measure, if the downstream side of the valve is protected by a safety valve or is discharged to atmosphere, the body and outlet can be constructed with a lower pressure rating than the inlet. Multi-stage trim is available in both unbalanced and pressure-balanced designs.

#### \*ADVANTAGES:

- REDUCE NOISE  $\leq 30$  dBA
- COST EFFECTIVE

#### \*APPLICATION:

- GAS SERVICES
- T  $\leq 1500^{\circ}$  F (816 $^{\circ}$  C)
- P  $\leq 15,000$  PSI (1034 BAR)

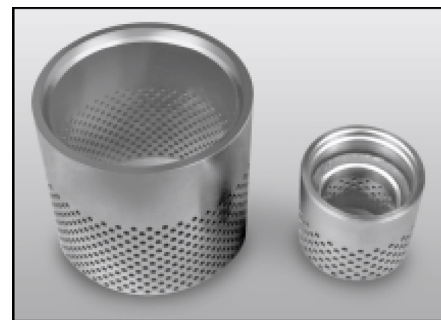


Figure 14.8.1: One and Two-Stage MegaStream Attenuators

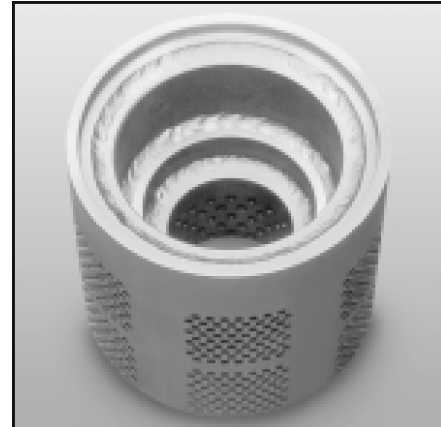


Figure 14.8.2: Four-Stage MegaStream Attenuator

## Turbulence Control

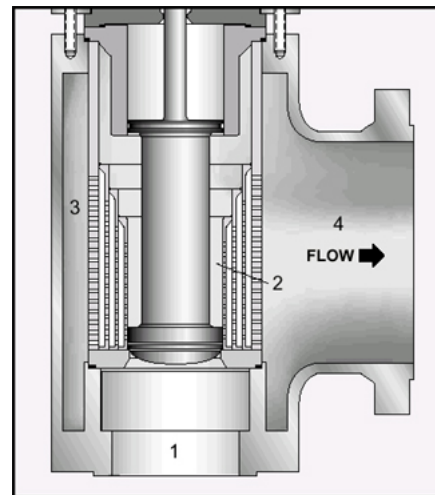
MegaStream trim effectively lowers the sound pressure levels associated with any turbulence generated within the valve. This turbulence is often carried into the downstream piping, where the localized pressure changes (resulting from the turbulence) vibrate the relatively thin pipe wall that radiates noise to the surroundings. With the MegaStream attenuator, each successive stage has additional holes or orifices, which increases the flow area and handles the increased gas volume resulting from the pressure drop.

As the flow leaves the final stage of the MegaStream attenuator, the turbulence is limited by controlling the physical size of the individual fluid streams. (In other words, the smaller fluid stream size exiting the final stage of the MegaStream trim limits the amount of turbulence energy present.) Further, the smaller turbulent eddies are more easily dissipated. The stages also effectively limit much of the sound vibration generated at the throttling area. This attenuating effect is made possible by the acoustic impedance characteristics of the material and design, which provide resistance to further transmission of incident sound energy. This acoustic impedance is especially effective in controlling noise when the plug is throttling close to the seat.

## Velocities

One of the fundamental design considerations with Valtek control valves with MegaStream trim is the establishment of acceptable velocities at every point as the flow passes through the valve. For gaseous control valve applications, it is desirable to keep the maximum outlet gas velocity below 0.33 Mach although higher velocities can be accommodated. Velocities must be assessed for the most difficult flowing conditions at the following critical points (as shown in Figure 14.8.3):

1. The inlet passageway to the valve
2. The internal flow area of the MegaStream attenuator at all plug positions
3. The gallery flow area formed between the outside diameter of the attenuator and the inside diameter of the valve body
4. The valve outlet passage flow area. For proper noise control, the downstream piping must be equal to or larger than the valve outlet size



**Figure 14.8.3: MegaStream Velocity Checkpoints**

## Flow Characteristics

As with the standard Mark One trim design, the flow characteristic for MegaStream trim is determined by the contour of the plug head. Three characteristics are available: equal percentage, linear and quick open.

## SIZING TIPS:

- **UNITS:** Double-check to ensure that each of your process conditions is using the correct units.
- **HIGH MACH LEVELS:** at the valve exit can generate high sound pressure levels eclipsing the noise generated by the valve itself. For this reason, it is recommended to maintain exit velocities less than 0.30 mach.
- **MULTI-STAGE:** trim calculations under the current IEC<sup>1</sup> standard focus on the last stage of the trim to predict the noise generation for the entire system, using a factor to estimate the effects of all the other stages. This can result in inaccurate noise prediction for certain trim. For this reason, special consideration should be given to trim with variable pressure drops across the different stages. A modification to the IEC standard is anticipated, enabling it to better assess trims with this attribute. *Performance!*<sup>®</sup> version 7.3.0 and later, provides an additional modified IEC calculation for valves with this characteristic.
- **VALVE STYLE:** selection plays an important role in noise control. For example, 50% of the noise generated in butterfly valves is transmitted downstream, but only 25% of the noise created by globe valves is transmitted downstream. This information can be found on a table in Section 15.

<sup>1</sup>CEI/IEC 60534-8-3:2000 Second Edition, Global Engineering Documents, July 2000



***This trim not yet released.***

## SEVERE SERVICE EQUIPMENT SELECTION

### 14.10 TIGER-TOOTH TRIM

#### Introduction

Tiger-Tooth trim effectively reduces sound pressure levels up to 30 dBA when installed in a globe-style control valve making it an effective choice for gas processes with high pressure drop conditions.

#### Design

The basic Tiger-Tooth design involves highly engineered concentric grooves (or teeth) machined into the face and backside of a series of circular stacked discs (called a stack), which also acts as a seat retainer. For easy assembly, the entire stack is tack-welded into one concentric unit and clamped in a conventional globe or angle body valve.

Flow passes from the center of the Tiger-Tooth stack through the teeth in a radial, wave-like manner to the outlet, undergoing a series of sudden contractions and expansions. This process reduces gas pressure in steps without the large, single pressure drop typical of conventional trims. Utilizing Tiger-Tooth trim reduces parts inventory and lowers cost because all parts: plug, pressure-balance sleeve, and bonnet are interchangeable with conventional Valtek Mark One globe valves. In addition, valves in sizes 16 through 36-inch may be custom-fabricated using an angle body configuration with the inlet at the side and the outlet on the bottom. To minimize the costs associated with large globe valve bodies, angle bodies in ANSI Classes 150 through 600 are generally constructed from a modified pipe 'Tee' with welded flanges. For applications requiring long strokes, special pneumatic cylinder, hydraulic or electric actuators are available.

#### Application

The Tiger-Tooth design features a unique flow path that permits radial expansion of the flow. The trim is effective on large pressure reductions in gases, because flow path expansion is provided to handle the increasing volume as the pressure is decreased. Each tooth is somewhat larger than the preceding tooth from inside to outside. The resultant increased flow area maintains acceptable gas velocity at every point across the discs.

#### Velocity Control

One of the fundamental design considerations for Tiger-Tooth trim is the establishment of acceptable velocities at every point as the flow passes through the valve. For gaseous control valve applications, it is desirable to keep the maximum outlet gas velocity below 0.3 Mach although higher velocities can be accommodated. Velocities must be assessed for the most difficult flowing conditions at the following critical points (as shown in Figure 14.10.2):

1. The inlet passageway to the valve
2. The internal flow area of the Tiger-Tooth stack at all plug positions
3. The flow area between the teeth, including inlet and outlet area of the stack
4. The gallery flow area formed between the outside diameter of the Tiger-Tooth stack and the inside diameter of the valve body
5. Outlet passage flow area

#### \*GAS APPLICATIONS

-REDUCE NOISE  $\leq 30$

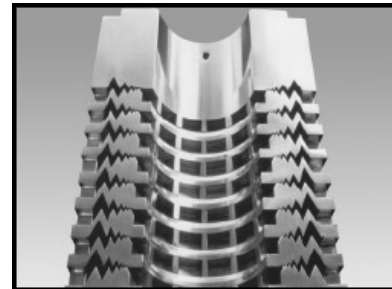


Figure 14.10.1: Tiger-Tooth Stack with a Five-Tooth Design

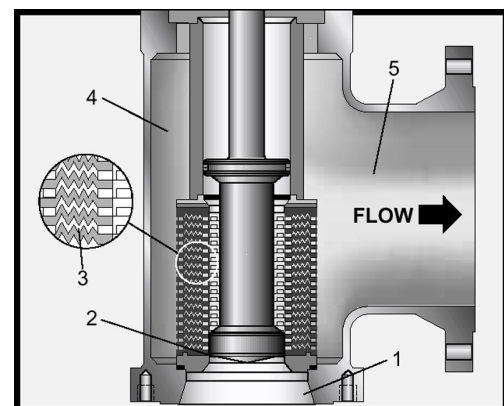


Figure 14.10.2: Tiger-Tooth Velocity Checkpoints (Pressure-Balanced Trim)

### Sudden Expansion and Contraction

An important mechanism acting to reduce the pressure in Tiger-Tooth trim is the sudden expansion and contraction phenomenon that takes place as the flow passes over the teeth.

Figure 14.10.3 illustrates this mechanism. Each channel is designed with narrow constricted passages (1) on either side of the expansion points (2). In this figure, the fluid velocity vectors lengthen as the velocity increases, and darken as the pressure decreases.

As the gas passes through each successive stage the pressure drops and the velocity increases in discrete, controlled amounts. These controlled, incremental stages enable Tiger-Tooth trim to achieve exceptional process control.

The Tiger-Tooth's ability to control flow velocities and pressures without the sudden spikes typical of traditional control valves dramatically reduces noise in the process line. Tiger-Tooth trim provides excellent noise attenuation when installed in high-velocity applications.

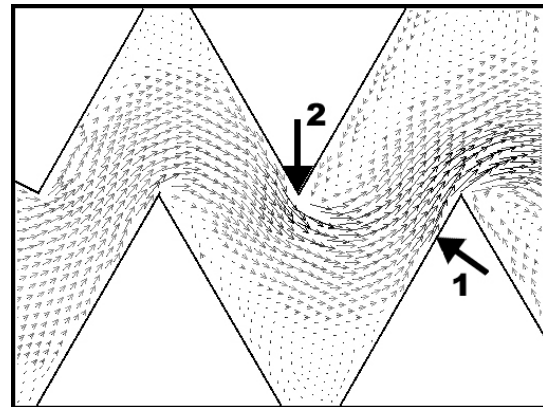


Figure 14.10.3: Sudden Expansion and Contraction Caused by Tiger-Tooth Design

### Flow Characteristics

Tiger-tooth trim is generally designed with a linear flow characteristic. Deviation from the linear characteristic inherent in a stacked disc design is avoided by lead-in areas machined into the valve plug and each individual disc. This permits the next flow passage to begin passing flow before the first passage has reached full capacity. Bi-linear or tri-linear trim can be furnished with portions of the stack having different flow capacities, permitting a flow characteristic approaching an equal percentage characteristic. Tiger-Tooth trim can also be manufactured with a full-open area at the top of the stack to provide additional flow capacity and tolerance for solids entrained in the process.

### Maintenance

Tiger-Tooth trim is designed for easy maintenance. Clearance between the stack and plug is designed for an optimum combination of stability and smooth operation. The clamped-in seat, top-entry trim design permits quick disassembly. The Tiger-Tooth stack is easily removed for inspection or cleaning. The Tiger-Tooth stack design is ideal for fluids with entrained particles. Fine and medium-sized particles easily pass through the discs because the design does not include any horizontal boundaries within the stack.

### Flow Capacity

The required flow capacity for an application can be determined through the standard ISA sizing equations. The main difference in sizing a standard globe valve and a Tiger-Tooth valve is that the Tiger-Tooth valve will not choke when it is not properly designed. In choosing a valve for a particular application, the user should consider not only the  $C_v$ , but also the velocity and the pressure ratio that must be accommodated.

## SIZING TIPS:

- **TIGER-TOOTH:** trim must be sized using precise measurements of the actual flow conditions. Tiger-tooth trim is often more expensive than other methods of noise attenuation, which should be sized first to reduce costs.
- **HIGH MACH LEVELS:** at the valve exit can generate high sound pressure levels eclipsing the noise generated by the valve itself. It is recommended to maintain exit velocities less than 0.30 mach.
- **MULTI-STAGE:** trim calculations under the current IEC<sup>1</sup> standard focus on the last stage of the trim to predict the noise generation for the entire system, using a factor to estimate the effects of all the other stages. This can result in inaccurate noise prediction for certain trim. For this reason, special consideration should be given to trim with variable pressure drops across the different stages. A modification to the IEC standard is anticipated, enabling it to better assess trims with this attribute. *Performance!*<sup>®</sup> version 7.3.0 and later, provides an additional modified IEC calculation for valves with this characteristic.

<sup>1</sup>CEI/IEC 60534-8-3:2000 Second Edition, Global Engineering Documents, July 2000

# SEVERE SERVICE EQUIPMENT SELECTION

## 14.11 MEGASTREAM PLATE

### Introduction

Similar in many respects to a MegaStream trim's attenuator, the MegaStream resistance plate is installed downstream from a valve as an additional solution to control valve noise (Figure 14.11.1). MegaStream plates can be installed between raised face flanges or welded in-line. Typical MegaStream plate applications include gas pressure reducing stations, gases vents and flare systems. MegaStream plates are designed for each individual application, providing sound pressure level (SPL) reductions of up to 15 dBA.

### Design

Each plate incorporates a series of stages (Figures 14.11.2, 14.11.3, 14.11.4). To control downstream line turbulence, each stage absorbs a portion of the pressure drop through its many multiple orifices. Depending on the type of gas and the pressure drop ratio, these plates may require between one and four stages. Standard MegaStream plates are constructed from carbon steel for both the housing and multi-hole stages. One additional option constructed from 304 stainless steel for both the housing and stages is available. Large plates are available with lifting plugs.

#### \*ADVANTAGES:

- REDUCE NOISE  $\leq 15$  dBA
- COST EFFECTIVE

#### \*APPLICATION:

- GAS SERVICES
- $T \leq 1500^{\circ} F$  ( $816^{\circ} C$ )
- $P \leq 15,000$  PSI (1034 BAR)

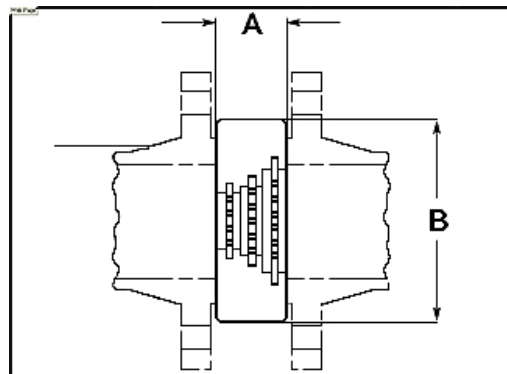


Figure 14.11.1: Cross-Section of a Three-Stage MegaStream Plate



Figure 14.11.2: Two-Stage MegaStream Plate

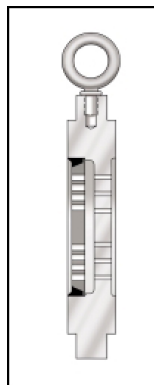


Figure 14.11.4: Cross-Section, Two-Stage MegaStream Plate with Lift Ring

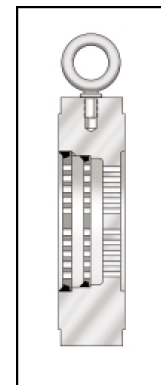


Figure 14.11.3: Cross-Section, Three-Stage MegaStream Plate with Lift Ring

### SIZING TIPS:

- **RESONANT EFFECTS** of piping systems can substantially amplify the sound pressure level of a system. At certain frequencies (it varies for different systems) downstream pipe acts as a wave-guide allowing noise to exit the system without any attenuation from the pipe walls. This effect can be controlled by changing the frequency of the sound waves, accomplished by reducing (in some cases increasing) the size of the outlet orifice.
- **NOISE GENERATION** is a function of velocity or Mach number, which correlates with the  $P_1/P_2$  ratio. Reducing the velocity through the plate can be an effective means of noise attenuation.
- **CONTACT THE FACTORY** for specific sizing information.



# SEVERE SERVICE EQUIPMENT SELECTION

## 14.12 MEGASTREAM DIFFUSERS

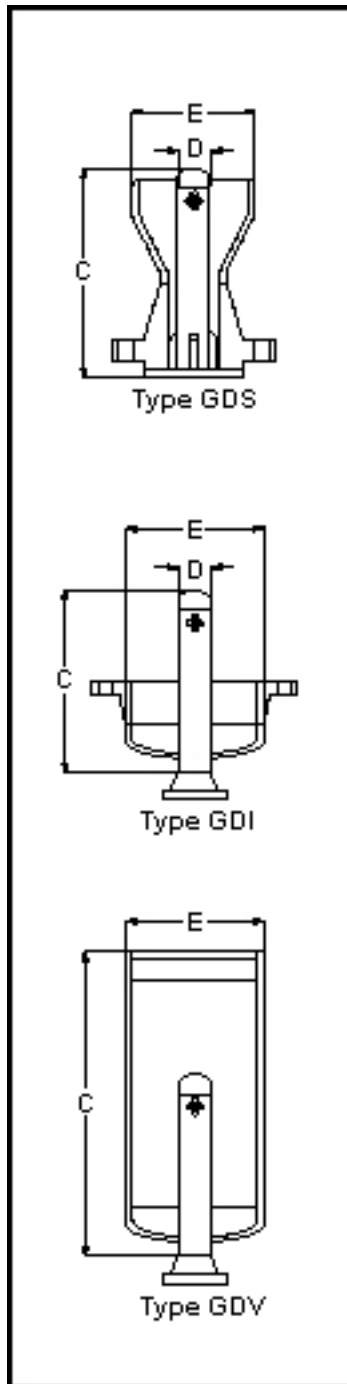


Figure 14.12.1: MegaStream Diffusers

### Introduction

Like the MegaStream plate, the MegaStream diffuser (Figure 14.12.2) can also be used in series with any style of valve to reduce the sound pressure level (up to 15 dBA), while eliminating the need for expensive valve trim. MegaStream diffusers share high-pressure drops with the control valve, yet control the sound pressure level by passing the flow through many small openings to eliminate excessive turbulence and energy.

### Design

Correct hole size and spacing are critical in determining the performance characteristics of the diffuser, Flowserve special-engineers each diffuser for a particular application. By design, the length of the diffuser and the number of holes vary to accommodate the flow capacity required. Thus the capacity of the diffuser is significantly greater than the MegaStream plate.

### Available Models

Two standard diffuser models are available:

GDS – Flowserve’s standard model with installation between the raised face flanges of the valve and line

GDI – Similar to GDS with welded in-line installation or to mating flanges; outlet is enlarged to eliminate a reducer

Additionally, diffusers are used in vent applications:

GDV – Diffuser with custom-engineered multi-hole design and outer shell

### SIZING TIPS:

- **SMALL EXIT ORIFICES** can be engineered to produce sound frequencies above audible levels (much like a dog whistle), effectively reducing the noise generation of the process.
- **NOISE GENERATION** is a function of velocity or Mach number, which correlates with the  $P_1/P_2$  ratio. Reducing the velocity through the valve is an effective means of noise attenuation.
- **CONTACT THE FACTORY** for specific sizing information.

### \*ADVANTAGES

- REDUCE NOISE  $\leq$  15 dBA
- REDUCE PRESSURE
- COST EFFECTIVE
- CAN BE COMBINED W/ TRIM

### \*APPLICATION

- ONE FLOW DIRECTION
- GAS SERVICE
- NO LARGE DEBRIS



Figure 14.12.2: MegaStream Diffusers

## SEVERE SERVICE EQUIPMENT SELECTION

### 14.13 MEGASTREAM VENT ELEMENTS

#### Introduction

In a blow off or vent system, tremendous energy in the form of noise is released at the open exit. Vent silencers attenuate this noise energy before it is released to the outside environment. MegaStream vent silencers are very effective in attenuating very high noise levels created when high-pressure gases are released to the atmosphere. When engineered in conjunction with an upstream control valve, the entire system can be optimized to attenuate the noise in smaller, less expensive solutions. Flowserve engineers can provide an optimized solution when presented with both the control valve and silencer requirements.

The MegaStream vent silencer is available in a variety of materials, and mounting configurations. The model number for MegaStream vent silencers is GDV

#### \*ADVANTAGES

- REDUCE NOISE  $\leq$  25 dBA
- REDUCE PRESSURE
- COST EFFECTIVE
- CAN BE COMBINED W/TRIM

#### \*APPLICATION

- ONE FLOW DIRECTION
- GAS VENTS & FLARE SYSTEMS
- NO LARGE DEBRIS

#### SIZING TIPS:

- **SMALL EXIT ORIFICES** can be engineered to produce sound frequencies above audible levels (much like a dog whistle), effectively reducing the noise generation of the process.
- **RESONANT EFFECTS** of piping systems can substantially amplify the sound pressure level of a system. At certain frequencies (which vary for different systems) downstream pipe acts as a wave-guide allowing noise to exit the system without any attenuation from the pipe walls. This effect can be controlled by changing the frequency of the sound waves, accomplished by reducing (in some cases increasing) the size of the outlet orifice.
- **NOISE GENERATION** is a function of velocity or Mach number, which correlates with the  $P_1/P_2$  ratio. Reducing the velocity through the vent element is an effective means of noise attenuation.
- **SOUND PRESSURE LEVELS** are normally reduced 6 dBA for each doubling of the distance from the source. Long distances will reduce noise even more due to the atmospheric absorption and attenuating effects of surrounding objects, walls and ground.
- **DIRECTION ANGLES** can result in up to 15dBA noise reduction in venting applications as shown in Figure 13-8 of section 13.
- **REFLECTIVE SURFACES** increase the sound measured near a valve. For a valve installed near a reflective surface (a hard floor or wall), add 3 dBA. For a valve installed near two reflective surfaces (a hard floor and wall), add 6 dBA. If the valve is near three reflective surfaces (two hard walls and hard floor), add 9 dBA. A valve installed in a small room with all reflective walls, floor, and ceiling can easily produce noise levels 30 or 40 dBA above that which the valve would produce in an area free of reflective surfaces. Additionally, if the pipe terminates near the valve the sound pressure level will be much greater; if the pipe immediately leaves the building after passing through a valve, the SPL will be much lower.
- **CONTACT THE FACTORY** for specific sizing information.



Figure 14.13.1 MegaStream Vent Element

# SEVERE SERVICE EQUIPMENT SELECTION

## 14.14 MEGASTREAM IN-LINE SILENCERS

### Introduction

For pipe noise applications beyond the range of MegaStream plates and diffusers, or control valve severe service trim, Flowserve provides an in-line silencer (Figure 14.14.1), which may be installed separately or in series with one of the other devices. The Valtek silencer consists of a series of tuned chambers and tubes filled with sound absorbing material (Figure 14.14.2), and is designed with staged pressure reduction.

### \*ADVANTAGES

- HIGH NOISE REDUCTION
- REDUCE PRESSURE
- CAN BE COMBINED W/ TRIM

### \*APPLICATION

- ONE FLOW DIRECTION
- GAS SERVICE
- NO LARGE DEBRIS

### SIZING TIPS:

- **VALVE STYLE** selection plays an important role in noise control. For example, 50% of the noise generated in butterfly valves is transmitted downstream, but only 25% of the noise created by globe valves is transmitted downstream. This information can be found on the valve style table in Section 15.
- **CONTACT THE FACTORY** for specific sizing information.

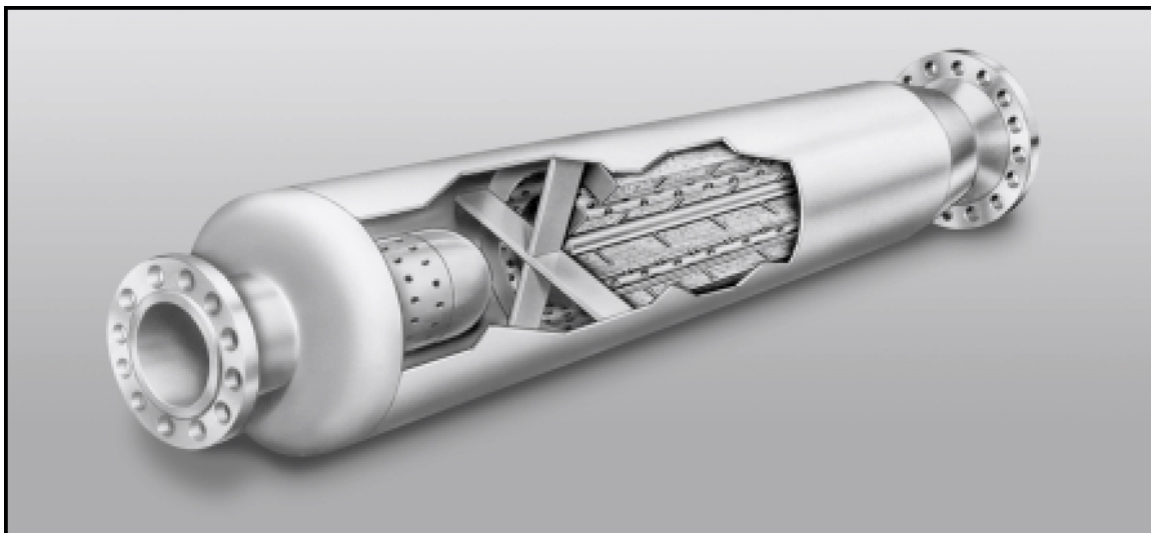


Figure 14.14.1: MegaStream in-line silencer

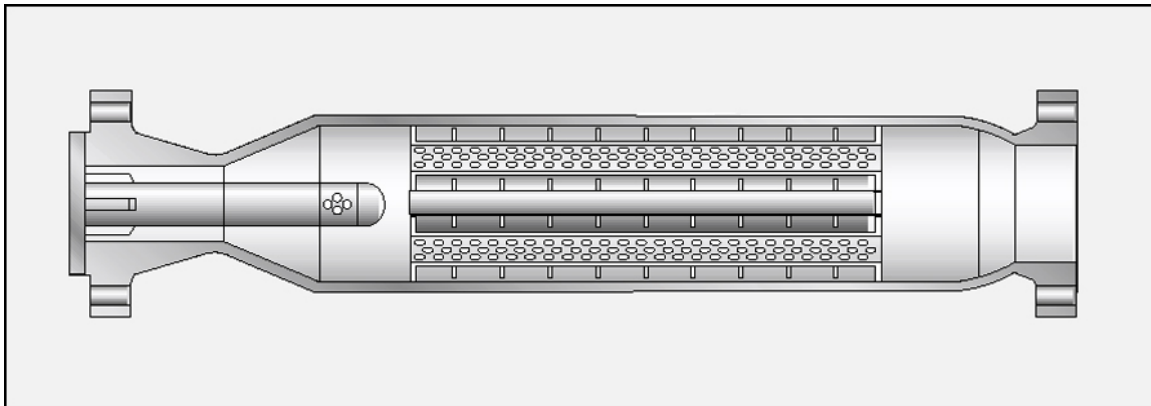


Figure 14.14.2: Construction of MegaStream in-line silencer

## SEVERE SERVICE EQUIPMENT SELECTION

### 14.15 TIGER-TOOTH VENT ELEMENTS

#### Introduction

For extremely difficult venting applications, a Tiger-Tooth stack (Figure 14.15.2) can be installed downstream from a valve to provide excellent noise control. By the addition of more discs, the stack can be lengthened to accommodate the flow and attenuation requirements. The stack is clamped in place by the housing and can be easily disassembled for routine maintenance. Tiger-Tooth stacks are available in sizes 1.5 through 42-inch.

Tiger-Tooth vent elements are designed using the same principles as Tiger-Tooth trim. The flow moves through the stack from inside to outside, encountering areas of expansion and compression in rapid succession. The areas of expansion and contraction are carefully calculated to maintain strict control of the pressure and velocity to gain maximum noise reduction.



Figure 14.15.1 Tiger-Tooth Vent Flow Pattern

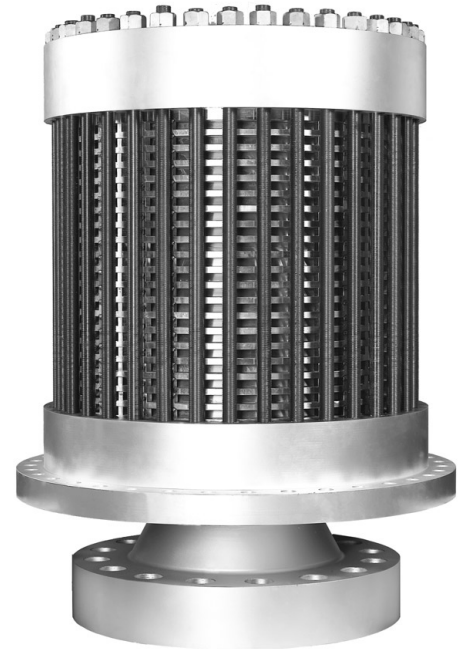


Figure 14.15.2 Tiger-Tooth Vent

#### SIZING TIPS:

- **SMALL EXIT ORIFICES** can be engineered to produce sound frequencies above audible levels (much like a dog whistle), effectively reducing the noise generation of the process.
- **RESONANT EFFECTS** of piping systems can substantially amplify the sound pressure level of a system. At certain frequencies (it varies for different systems) downstream pipe acts as a wave-guide allowing noise to exit the system without any attenuation from the pipe walls. This effect can be controlled by changing the frequency of the sound waves, accomplished by reducing (in some cases increasing) the size of the outlet orifice.
- **NOISE GENERATION** is a function of velocity or Mach number, which correlates with the  $P_1/P_2$  ratio. Reducing the velocity through the vent element is an effective means of noise attenuation.
- **SOUND PRESSURE LEVELS** are normally reduced 6 dBA for each doubling of the distance from the source. Long distances will reduce noise even more due to the atmospheric absorption and attenuating effects of surrounding objects, walls and ground.
- **REFLECTIVE SURFACES** increase the sound measured near a valve. For a valve installed near a reflective surface (a hard floor or wall), add 3 dBA. For a valve installed near two reflective surfaces (a hard floor and wall), add 6 dBA. If the valve is near three reflective surfaces (two hard walls and hard floor), add 9 dBA. A valve installed in a small room with all reflective walls, floor, and ceiling can easily produce noise levels 30 or 40 dBA above that which the valve would produce in an area free of reflective surfaces. Additionally, if the pipe terminates near the valve the sound pressure level will be much greater; if the pipe immediately leaves the building after passing through a valve, the SPL will be much lower.
- **CONTACT THE FACTORY** for specific sizing information.